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* NOTICES *

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2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

Epitome

(57) [Abstract]
[Technical problem] It is comparatively easy and the mechanical optical switch the joint error excelled [optical switch] small that the configuration suitable for low cost-ization was also in properties, such as transmission loss, is obtained.
[Means for Solution] While locating a recursion reflector in the close outgoing radiation optical paths 32 and 34 of light, an optical-path change is made to perform in the mechanical optical switch which performs an optical-path change by locating in the above-mentioned close outgoing radiation optical paths 31-34 by turns V character-like recursion reflector 10a and W character-like recursion reflector 20a which were formed beforehand by changing the shape of a reflex of the recursion reflector.

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CLAIMS

[Claim(s)]
[Claim 1] The mechanical optical switch characterized by making it make an optical-path change perform by locating in the above-mentioned close outgoing radiation optical path by turns the V character-like recursion reflector and W character-like recursion reflector which were formed beforehand in the mechanical optical switch which performs an optical-path change by changing the shape of a reflex of the recursion reflector while locating a recursion reflector in the close outgoing radiation optical path of light.
[Claim 2] The mechanical optical switch characterized by performing an optical-path change by locating by turns the 1st movable reflective member which forms a V character-like recursion reflector, and the 2nd movable reflective member which forms a W character-like recursion reflector on said optical path in claim 1.
[Claim 3] The mechanical optical switch characterized by performing an optical-path change by forming a V character-like recursion reflector and a W character-like recursion reflector in one set-type movable reflective member, and moving this set-type movable reflective member in claim 1.
[Claim 4] It is the mechanical optical switch characterized by forming mutually [turn to the same direction and] both the V character-like recursion reflector of said set-type movable reflective member, and the W character-like recursion reflector together with the direction of a laminating in claim 3.
[Claim 5] The mechanical optical switch characterized by making the same field as the reflector in which two reflectors located in the both-sides edge in claim 4 among four reflectors which form a W character-like recursion reflector form a V character-like recursion reflector.
[Claim 6] It is the mechanical optical switch characterized by being formed so that the V character-like recursion reflector of said set-type movable reflective member and a W character-like recursion reflector may turn to [both] the different direction mutually in claim 3 and it may be located on the same field.
[Claim 7] It is the mechanical optical switch which said set-type movable reflective member is plate-like in claim 6, and is both characterized by the thing by which a V character-like recursion reflector is formed in the end side face, and for which the W character-like recursion reflector is formed in the the opposite side face.
[Claim 8] The mechanical optical switch characterized by locating a V character-like recursion reflector and a W character-like recursion reflector by turns on said optical path in claims 1-6 by carrying out both-way migration of said set-type movable reflective member.
[Claim 9] The mechanical optical switch characterized by locating a V character-like recursion reflector and a W character-like recursion reflector by turns on said optical path by rotating said set-type movable reflective member in claims 1-7.
[Claim 10] The mechanical optical switch characterized by locating a V character-like recursion reflector and a W character-like recursion reflector by turns on said optical path in claims 1-9 by carrying out the migration drive of said set-type movable reflective member with a stepping motor.
[Claim 11] The mechanical optical switch characterized by having arranged said both set-type movable reflective members and stepping motors on the same side, and connecting both through a driving mechanism in claim 10.
[Claim 12] The mechanical optical switch characterized by using a spur gear as said driving mechanism in claim 11.

[Claim 13] the mechanical optical switch characterized by locating said optical path in a line in parallel on the same flat surface, boiling it, respectively, and optical coupling being carried out to an optical-fiber-transmission way in claims 1-12.

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3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is used for the change of an optical-fiber-transmission way or optical sender-receiver-terminal equipment, concerning the mechanical optical switch which changes the transmission direction of light.
[0002]
[Description of the Prior Art] Although it has a part for mechanical moving part in order that a mechanical optical switch may change the transmission direction of light, the principle is widely used from modification of the transmission root, the change of a terminal unit, etc. by that it is simple and comparatively cheap in optical communication, especially the optical communication using an optical-fiber-transmission way.
[0003] Drawing 8 shows an example of the conventional mechanical optical switch. The optical switch shown in this drawing is a thing of a method which changes an optical path using a mirror (light reflex mirror), and is constituted using the radar clutter member 80 and the movable reflective member 90.
[0004] The radar clutter member 80 has the 1st and 2nd reflector 81 and 82 which opens the include angle of a right angle (90 degrees) in the shape of V character mutually though nothing. The V character-like reflectors 81 and 82 of this right angle form the recursion reflector which reflects incident light 1A and 2A in the opposite direction of return by return. That is, recursion reflection to which the optical paths 31 and 33 of incident light 1A and 2A and the optical paths 32 and 34 of outgoing radiation light 1B and 2B become parallel is performed. Each optical paths 31-34 are optical paths in optical free propagation space, and are usually put in order in parallel on the same flat surface. Optical association of each optical paths 31-34 is carried out on the optical-fiber-transmission way arranged in the predetermined location, respectively, respectively.
[0005] The movable reflective member 90 has mutually the 1st and 2 reflectors 91 and 92 which close the include angle of a right angle (90 degrees) in the shape of reverse V character though nothing. this movable reflective member 90 is attached in the point of a cantilever 95 — having — the upper and lower sides — it is held movable. A cantilever 95 moves between two locations of a top and the bottom for the movable reflective member 90 by the suitable machine driving means.
[0006] When the movable reflective member 90 moves to a bottom location, as shown in (a), only the radar clutter member 80 is located on the close outgoing radiation optical path 31 - 34, and the recursion reflector of the shape of V character by the 1st and the 2nd reflector 81 and 82 is formed. In this case, sequential reflection is carried out in the 1st reflector 81 and the 2nd reflector 82, and outgoing radiation of the incident light 1A of an optical path 31 is carried out to an optical path 34. Moreover, sequential reflection is carried out in the 2nd reflector 82 and the 1st reflector 81, and outgoing radiation of the incident light 2A of an optical path 33 is carried out to an optical path 32.
[0007] On the other hand, when the movable reflective member 90 comes to a top location, as shown in (b), a radar clutter member and the 80 movable reflective member 90 are located on the above-mentioned close outgoing radiation optical path 31 - 34, and the recursion reflector of the shape of W character by both the members 80 and 90 is formed in it. This W character-like recursion reflector is formed of the V character-like recursion reflective section by the 1st reflector 81 by the side of the radar clutter member 80, and the 1st reflector 91 by the side of the movable reflective member 90, and the V character-like

recursion reflective section by the 2nd reflector 82 by the side of the radar clutter member 80, and the 2nd reflector 92 by the side of the movable reflective member 90.
[0008] In this case, sequential reflection is carried out in the 1st reflector 81 by the side of the radar clutter member 80, and the 1st reflector 91 by the side of the movable reflective member 90, and outgoing radiation of the incident light 1A of an optical path 31 is carried out to an optical path 32. Moreover, sequential reflection is carried out in the 2nd reflector 82 by the side of the radar clutter member 80, and the 2nd reflector 92 by the side of the movable reflective member 90, and outgoing radiation of the incident light 2A of an optical path 33 is carried out to an optical path 34. Thus, optical switch actuation which changes and exchanges the optical paths 32 and 34 of outgoing radiation light 1B and 2B is performed.
[0009] Since the mechanical optical switch mentioned above has the incident light ways 31 and 33 and the outgoing radiation optical paths 32 and 34 in a same side, it has the advantage that the degree of freedom on arrangement is high while it is advantageous to a miniaturization.
[0010]
[Problem(s) to be Solved by the Invention] Although the movable reflective member 90 is moved and an optical path is changed in the conventional mechanical optical switch mentioned above, the change must be performed so that the location of the outgoing radiation optical paths 32 and 34 may not be changed. Although optical coupling of the outgoing radiation optical paths 32 and 34 is carried out to the optical-fiber-transmission way positioned beforehand, if the location of the outgoing radiation optical paths 32 and 34 is changed, an error (error) will arise in association with an optical-fiber-transmission way. If this joint error becomes large, transmission loss will increase, and optical transmission will be intercepted when the worst.
[0011] In order to make the above-mentioned joint error small, it is necessary to position mutually the radar clutter member 80, the movable reflective member 90, and an optical-fiber-transmission way correctly. It is necessary to keep highly precise the relative precision between both on the need of forming the recursion reflector of the shape of W character which reflects incident light 1A and 2A in the opposite direction of return of the direction of incidence by return correctly, as much as possible especially about the radar clutter member 80 and the movable reflective member 90. However, if it is going to make high degree of accuracy and high stability position the movable reflective member 90 constituted movable mechanically to the radar clutter member 80, the problem that there are many need parts of alignment adjustment, it is as complicated as an erector, and cost becomes high will arise. Furthermore, although the sufficient high degree of accuracy and the stability also for the machine drive system to which the movable reflective member 90 is moved are required, this also brings about complication of a process, and high cost-ization.
[0012] Drawing 9 shows the location gap d condition of outgoing radiation light 1B produced by relative-position gap of the above-mentioned movable reflective member 90. When the location gap delta x of x directions (longitudinal direction of space) produces (a) in this drawing, When location gap deltay of the direction (the vertical direction of space) of y produces (b) and the rotation gap deltathetaz centering on z directional axis (perpendicular direction of space) produces (c), (d) shows the case where the rotation gap deltathetax centering on x directional axes produces (e), respectively, when the rotation gap deltathetaz centering on y directional axis arises. it is shown in this drawing — as — relative-position gap (deltax, delta y, deltathetaz, deltathetay) of various modes between the movable reflective member 90 and the radar clutter member 80 — being generated — the any — although — the big gap d is brought about in the location or direction of outgoing radiation light 1B by which recursion reflection was carried out. And this gap d brings about a property fall called transmission loss increase.
[0013] This invention was made in view of the above problems, and that purpose is comparatively easy and is to offer the mechanical optical switch the joint error excelled [optical switch] small that the configuration suitable for low cost-ization was also in properties, such as transmission loss.
[0014]
[Means for Solving the Problem] The means by this invention is characterized by making it make an optical-path change perform in the mechanical optical switch which performs an optical-path change by locating in the above-mentioned close outgoing radiation optical path by turns the V character-like recursion reflector and W character-like recursion reflector which were formed beforehand by changing the shape of a reflex of the recursion reflector while it locates a recursion reflector in the close outgoing radiation optical path of light.
[0015] The mechanical optical switch the joint error excelled [optical switch] small the above-mentioned means ****** and that the configuration which was comparatively easy and was suitable for low cost-ization was also in properties, such as transmission loss, can be obtained. Furthermore, in this invention, the

following means are offered as a desirable mode of the above-mentioned means.
[0016] That is, the above-mentioned optical-path change can be made to perform by locating by turns the 1st movable reflective member which forms a V character-like recursion reflector, and the 2nd movable reflective member which forms a W character-like recursion reflector on the above-mentioned optical path. Moreover, a V character-like recursion reflector and a W character-like recursion reflector can be formed in one set-type movable reflective member, and it can be made to carry out also by moving this set-type movable reflective member.
[0017] Both the V character-like recursion reflector of the above-mentioned set-type movable reflective member and a W character-like recursion reflector can turn to the same direction, and can form it together with the direction of a laminating mutually. In this case, two reflectors located in that both-sides edge among four reflectors which form a W character-like recursion reflector can be formed in the same field as the reflector which forms a V character-like recursion reflector.
[0018] The V character-like recursion reflector of the above-mentioned set-type movable reflective member and a W character-like recursion reflector may be formed so that the different direction may be turned to [both] mutually and it may be located on the same side. For example, while forming a V character-like recursion reflector in the end side face of a plate-like set-type movable reflective member, it is good to form a W character-like recursion reflector in the the opposite side face.
[0019] What is necessary is to round-trip-move or just to rotate the above-mentioned set-type movable reflective member, in order to locate a V character-like recursion reflector and a W character-like recursion reflector by turns on the above-mentioned optical path. The stepping motor which can be driven by open loop control as the migration driving means is suitable. Although a stepping motor has detent torque, this detent torque brings about the effectiveness of holding the positioning condition of a movable reflective member to stability.
[0020] Thin shape-ization of an optical switch can be achieved by arranging both a set-type movable reflective member and a stepping motor on the same field, and connecting both through a driving mechanism. As a driving mechanism in this case, the spur gear is suitable.
[0021] The means of this invention mentioned above is suitable for the mechanical optical switch of the type with which the above-mentioned optical path is located in a line in parallel on the same flat surface, and optical coupling of each is carried out to an optical-fiber-transmission way.
[0022]
[Embodiment of the Invention] Drawing 1 shows the 1st example of the mechanical optical switch by this invention. In this drawing, in (a), the top view which looked at the close outgoing radiation optical paths 31-34 of a lightwave signal from the bottom, and (b) show an A-A sectional view, and (c) shows an important section perspective view, respectively.
[0023] The mechanical optical switch shown in this drawing is constituted using the actuator (both-way driving means) 41 which locates by turns the 1st movable reflective member 10 which has V character-like recursion reflector 10a, the 2nd movable reflective member 20 which has W character-like recursion reflector 20a, and both the reflective members 10 and 20 on the close outgoing radiation optical path 31-34. The close outgoing radiation optical paths 31-34 are optical paths in optical free propagation space, and they are arranged so that it may usually stand in a line in parallel on the same flat surface. Optical association of each optical paths 31-34 is carried out on the optical-fiber-transmission way (illustration abbreviation) arranged in the predetermined location, respectively.
[0024] The 1st movable reflective member 10 forms V character-like recursion reflector 10a which reflects incident light 1A and 2A in the opposite direction of return by return according to the 1st and 2nd reflector 11 and 12 which opens the include angle of a right angle (90 degrees) in the shape of V character mutually though nothing. The 2nd movable reflective member 20 forms W character-like recursion reflector 20a which consists of the two V character-like recursion reflective sections according to the 1-4th reflectors 21-24 arranged in the shape of W character at an angle of a right angle (90 degrees). In this case, about two reflectors 21 and 24 located in the both-sides edge of W character-like recursion reflector 20a among the reflectors 21-24 of the 2nd movable reflective member 20, the same field as two reflectors 11 and 12 which make V character-like recursion reflector 10a of the 1st movable reflective member 10 is made.
[0025] Between the locations of two upper and lower sides is moved with the actuator 41 of a linear drive mold by the 1st and 2nd movable reflective member 10 and 20 both mentioned above. an actuator 41 — for example, electromagnetism — it is constituted using a solenoid etc. and both-way migration of the above-mentioned members 10 and 20 is carried out up and down.

[0026] Drawing 2 shows switching of the above-mentioned mechanical optical switch. The above-mentioned mechanical optical switch operates as an optical switch which changes the optical paths 32 and 34 of outgoing radiation light 1B and 2B by turns by locating the 1st and 2nd movable reflective member 10 and 20 by turns on an optical path 31 - 34, as it is indicated in (b) as (a). (a) shows a condition when V character-like recursion reflector 10a of the 1st movable reflective member 10 is located on an optical path 31 - 34. In this condition, recursion reflection is carried out in reflectors 11 and 12, and outgoing radiation (1B) of the incident light 1A of an optical path 31 is carried out on an optical path 34. Moreover, recursion reflection is carried out in reflectors 12 and 11, and outgoing radiation (2B) of the incident light 2A of an optical path 33 is carried out on an optical path 32. Outgoing radiation light 1B on each outgoing radiation optical path 32 and 34 and 2B are led to the optical-fiber-transmission way located in the point of the optical paths 32 and 34, respectively. The optical-fiber-transmission way is arranged beforehand in the location which carries out optical coupling to the above-mentioned optical paths 31-34. (b) shows a condition when W character-like recursion reflector 20a of the 2nd movable reflective member 20 is located on an optical path 31 - 34. In this condition, recursion reflection is carried out in reflectors 21 and 22, and outgoing radiation (1B) of the incident light 1A of an optical path 31 is carried out on an optical path 32. Moreover, recursion reflection is carried out in reflectors 23 and 24, and outgoing radiation (2B) of the incident light 2A of an optical path 33 is carried out on an optical path 34. Also in this case, outgoing radiation light 1B on each outgoing radiation optical path 32 and 34 and 2B are led to the optical-fiber-transmission way located in the point of those optical paths 32 and 34, respectively. By making the above (a) and two conditions of (b) change mechanically with an actuator 41, optical switch actuation which changes the optical paths 32 and 34 of outgoing radiation light 1B and 2B by turns is performed.
[0027] Here, the V character-like recursion reflector located on an optical path 31 - 34 in the condition of (a) is beforehand formed in the 1st movable reflective member 10. Similarly, the W character-like recursion reflector located on an optical path 31 - 34 in the condition of (b) is beforehand formed in the 2nd movable reflective member 20. Therefore, an optical path is temporarily positioned to the 1st movable reflective member 10, and since the configuration of recursion reflector 20a is correctly maintained to it, the 2nd movable reflective member 20 can mitigate the effect by location gap about the degree of freedom which is three. That is, since change does not arise in the configuration of the recursion reflectors 10a and 20a which each movable reflective members 10 and 20 form in each even if location gap arises in the movable reflective members 10 and 20, the situation where big location gap arises in the outgoing radiation optical paths 32 and 34 is avoidable. Thereby, a joint error can offer the mechanical optical switch which was small excellent in properties, such as transmission loss. Next, the detail is given.
[0028] Drawing 3 illustrates the behavior of the outgoing radiation optical paths 32 and 34 when location gap arises in the above-mentioned movable reflective members 10 and 20. In this drawing, (a) shows the case where the location gap delta x of x directions arises. In this case, location gap of the outgoing radiation optical paths 32 and 34 is not produced at all. (b) shows the case where the rotation gap deltathetaz centering on z directional axis arises. In this case, since the configuration (90 degrees) of a recursion reflector does not change, as for a close outgoing radiation optical path, parallel are maintained. Since the include angle between reflectors shifts from 90 degrees, it becomes impossible on the other hand, to maintain parallel in the case of the conventional movable reflector mentioned above. For such a reason, by this invention, even if the rotation gap deltathetaz arises, compared with the former, gap of an optical path can be suppressed to min. (c) shows the case where the rotation gap deltathetax centering on x directional axes arises. Since the configuration of a recursion reflector does not change in this case, either, x components serve as parallel light. However, although it has the include angle of z component when the effect of the inclination of deltathetax is seen from a reflector, it cancels by two reflection and outgoing radiation light returns to the same place.
[0029] Although optical coupling of the outgoing radiation optical paths 32 and 34 is carried out to the optical-fiber-transmission way positioned beforehand, if even recursion reflection is performed correctly, even if it may carry out the parallel displacement of the optical-path location a little, the direction of an optical path will not change. Since it does not say that location gap is expanded as it goes previously if the direction does not change, optical paths 32 and 34 do not produce a joint error which is accompanied by big transmission loss. Moreover, alignment correction is easy if only location gap to a parallel direction becomes.
[0030] Drawing 4 shows the important section of the 2nd example of this invention. In the 1st example mentioned above, although two movable reflective

members 10 and 20 were used, a mechanical optical switch consists of this 2nd example using one set-type movable reflective member 51 united with the detail part.
[0031] V character-like recursion reflector 10a and W character-like recursion reflector 20a turn [members / 51 / both / set-type movable reflective] to the same direction, and it is mutually formed in them together with the direction of a laminating. V character-like reflector 10a is formed in the thickness part of the top one half of a member 51, and the 1st and 2nd reflector 11 and 12 which faces this part aslant at an angle of a right angle (90 degrees) is formed. W character-like reflector 20a is formed in the thickness part of the bottom one half of a member 51, and the 1st which makes the two V character-like recursion reflective sections - the 4th reflector 21-24 are formed in this part. If this set-type movable reflective member 51 is used, two movable reflective members 10 and 20 currently used for said 1st example can be gathered on one components, and, thereby, assembly and an alignment process can be made to increase the efficiency of and simplify further.
[0032] Moreover, it can form in the same field as two reflectors 11 and 12 which make V character-like recursion reflector 10a about two reflectors 21 and 24 located in the both-sides edge among four reflectors 21-24 which form W character-like recursion reflector 20a. Therefore, about the reflectors 11, 12, 21, and 24, it is processible as one reflector. This is convenient when simplifying manufacture of the reflective member 51.
[0033] Drawing 5 shows the 3rd example of this invention. As shown in (a), the plate-like set-type movable reflective member 52 arranged so that V character-like recursion reflector 10a and W character-like recursion reflector 20a might be located on the same side is used for the mechanical optical switch of this example. As for this set-type movable reflective member 52, V character-like recursion reflector 10a is formed in that end side face, and W character-like recursion reflector 20a is formed in the other end side face rotated 180 degrees from there. That is, both the reflectors 10a and 20a are formed so that the the opposite direction may be turned to mutually on the same flat surface. This set-type movable reflective member 52 has a superficial configuration, and since it is monotone, it has the advantage that production is easy.
[0034] As shown in (b), the above-mentioned set-type movable reflective member 52 is connected with revolving-shaft 42a of the rotation actuator 42, and is rotated 180 degrees along the same flat-surface top as the close outgoing radiation optical paths 31-34. Thereby, as shown in (c) or (d), V character-like recursion reflector 10a and W character-like recursion reflector 20a can be located by turns on the close outgoing radiation optical path 31 - 34.
[0035] The stepping motor is used for the above-mentioned rotation actuator 42. Although this SUTEPPIN motor carries out the rotation drive of the movable reflective member 52 with the travel of 1 for the integer of 180 degrees, at the time of a rotation halt, the detent torque holding that halt location (include angle) arises. This detent torque brings about the positioning effectiveness of making the above-mentioned movable reflective member 52 standing it still to stability in an orientation.
[0036] In addition, it is not necessary to necessarily form the V character-like recursion reflector of a set-type movable reflective member, and a W character-like recursion reflector in a the opposite side face, and they turn to [both] the different direction mutually, and should just be located on the same side.
[0037] Drawing 6 shows the 4th example of this invention. In this example, V character-like recursion reflector 10a and W character-like recursion reflector 20a are located by turns on the close outgoing radiation optical path 31-34 by rotating the set-type movable reflective member 51 shown in drawing 1 . In this case, the rotation drive of the movable reflective member 51 is carried out a core [the direction of an optical axis of optical paths 31-34]. The rotation actuator 42 which used the stepping motor performs a rotation drive. Since a stepping motor has detent torque as mentioned above, it can hold the halt location of the movable reflective member 51 to stability.
[0038] Drawing 7 shows the 5th example of this invention. As shown in this drawing, in this example, both the stepping motors 421 as an actuator made to rotate the tabular set-type movable reflective member 52 shown in drawing 5 and this movable reflective member 52 are arranged on the same side. The stepping motor 421 and the movable reflective member 52 are connected through the spur gear 422, 423 which makes a rotation driving mechanism. 420 shows the installation base of each part material (423 421- 52). In this example, there is an advantage that the whole can be constituted in a thin shape, by arranging the movable reflective member 52 and the motor 421 on the same field.
[0039] As mentioned above, although this invention was explained based on the typical example, various modes are possible for this invention also besides having mentioned above. For example, various configurations are possible for the set-type reflective member which forms the recursion reflector of the shape of

the shape of V character, and W character in one also besides having mentioned above.
[0040]
[Effect of the Invention] According to this invention, it is comparatively easy and the mechanical optical switch the joint error excelled [optical switch] small that the configuration suitable for low cost-ization was also in properties, such as transmission loss, can be obtained.

[Translation done.]
* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the top view, sectional view, and important section perspective view showing the 1st example of the mechanical optical switch by this invention.
[Drawing 2] It is drawing showing switching of the mechanical optical switch shown in drawing 1 .
[Drawing 3] It is drawing which illustrates the behavior of an outgoing radiation optical path when location gap of a ****** member arises with the mechanical optical switch of this invention.
[Drawing 4] It is the perspective view and sectional view showing the important section of the 2nd example of this invention.
[Drawing 5] They are the perspective view showing the configuration and actuation of the 3rd example of this invention, a side elevation, and a top view.
[Drawing 6] It is the side elevation showing the 4th example of this invention.
[Drawing 7] It is the side elevation showing the 5th example of this invention.
[Drawing 8] They are the top view showing the conventional mechanical optical switch, a sectional view, and a perspective view.
[Drawing 9] It is drawing showing the location gap condition of the outgoing radiation light produced by relative-position gap of a movable reflective member with the conventional mechanical optical switch.
[Description of Notations]
1A, 2A Incident light
1B, 2B Hikaru Idei
10 1st Movable Reflective Member
10a V character-like recursion reflector
11 12 The 1st and 2nd reflector which makes a V character-like recursion reflector
20 2nd Movable Reflective Member
20a W character-like recursion reflector
21-24 The 1st which makes a W character-like recursion reflector - the 4th reflector
31 33 Incident light way
32 34 Outgoing radiation optical path
41 Actuator (Both-way Drive)
42 Actuator (Rotation Drive)
42a Revolving shaft
420 Installation Base
421 Stepping Motor
422, 423 Spur gear
51 52 Set-type movable reflective member
80 Radar Clutter Member (Former)
81 82 Reflector
90 Movable Reflective Member (Former)
91-92 Reflector
95 Cantilever

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* NOTICES *

DRAWINGS

[Drawing 1]

[Drawing 2]

[Drawing 3]

[Drawing 4]

[Drawing 5]

[Drawing 6]

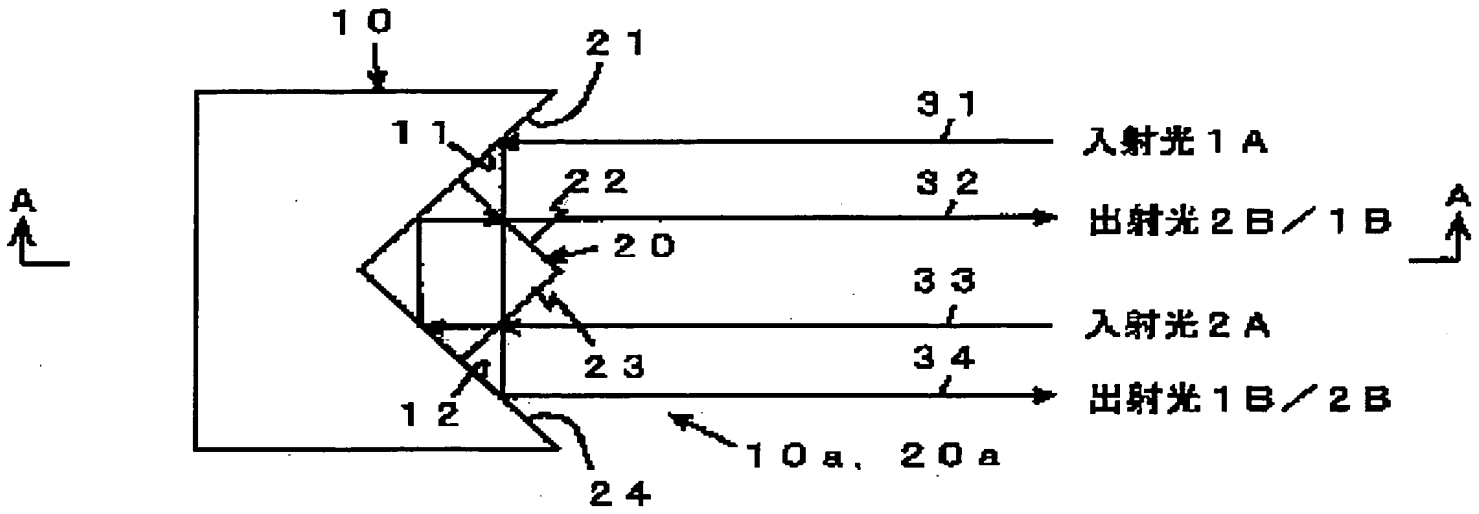
[Drawing 7]

[Drawing 8]

[Drawing 9]

[Translation done.]

(a)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11
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32
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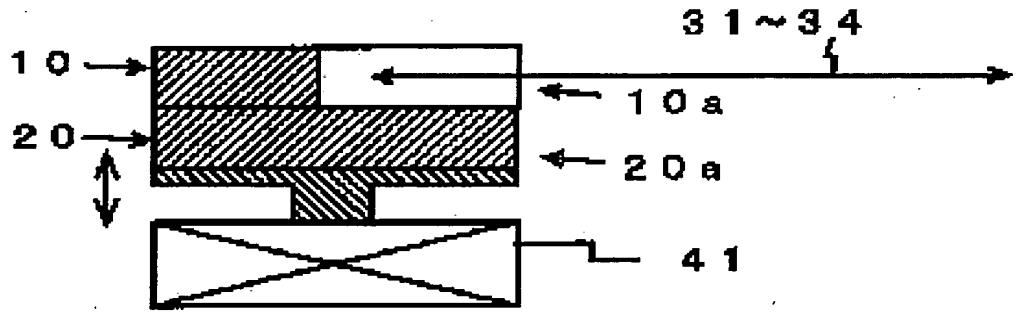
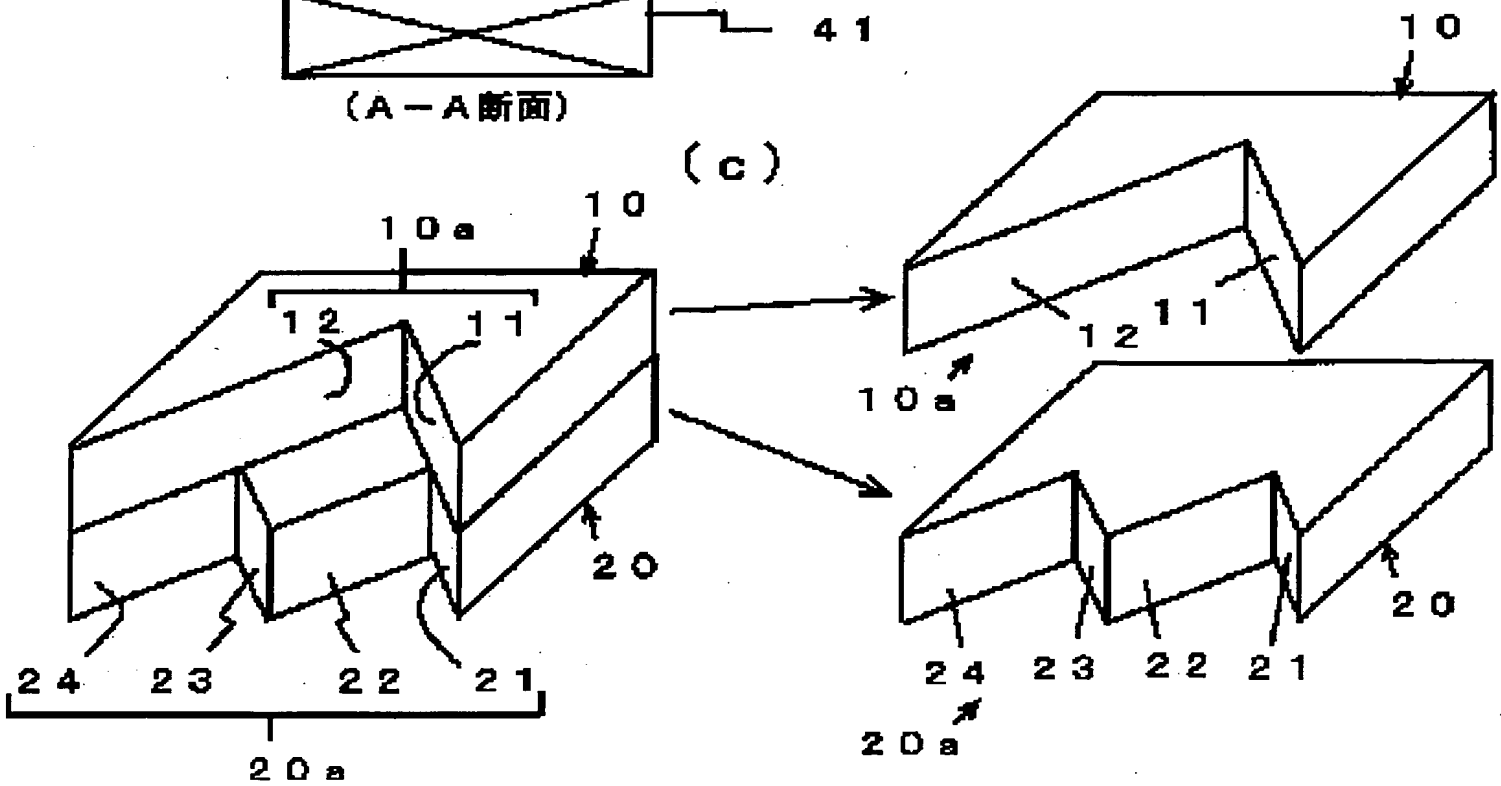
入射光２A
23
34
12
出射光１B／２B
10a、20a
24

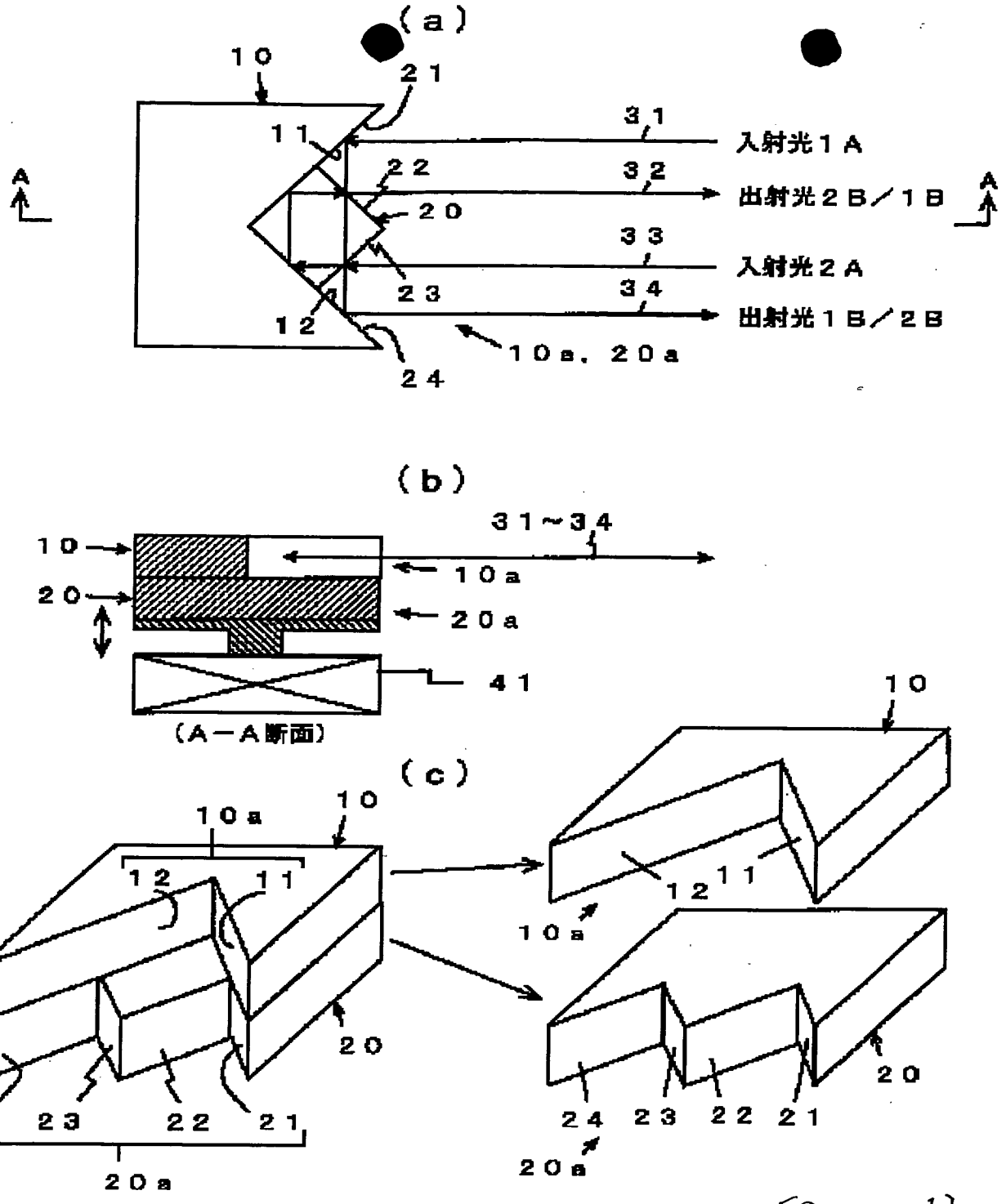
(b)


31～34
10
10a
20
20a
41

(A－A断面)

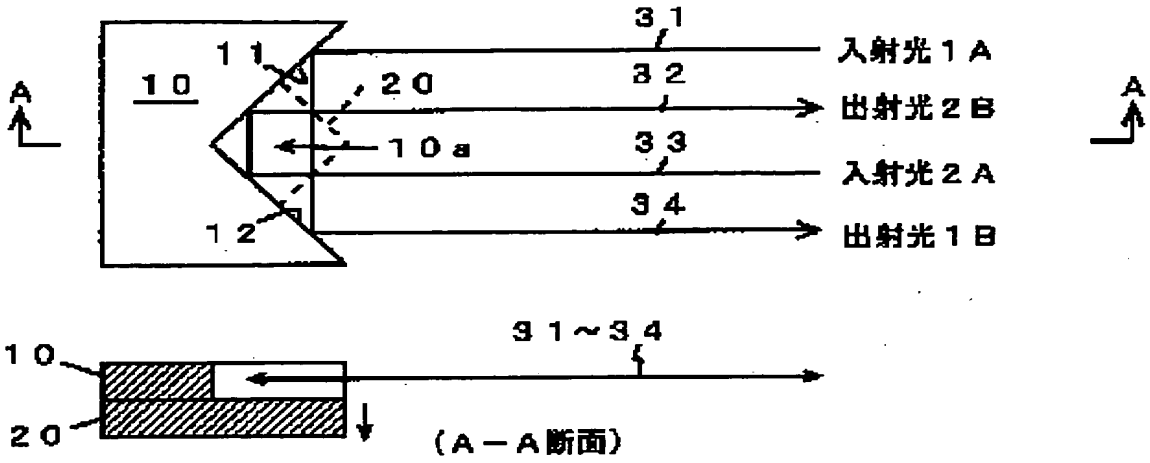
(c)


10
10a
12
11
20
24
23
22
21
20a
10
12
11
10a
20
24
23
22
21
20a


(a)
10
21
11
31
入射光１A
22
32
出射光２B／１B
A
A
20
33
入射光２A
23
34
出射光１B／２B
12
10a, 20a
24
(b)
31～34
10
10a
20
20a
41
(A－A断面)
(c)
10
10a
12
11
20
24
23
22
21
20a

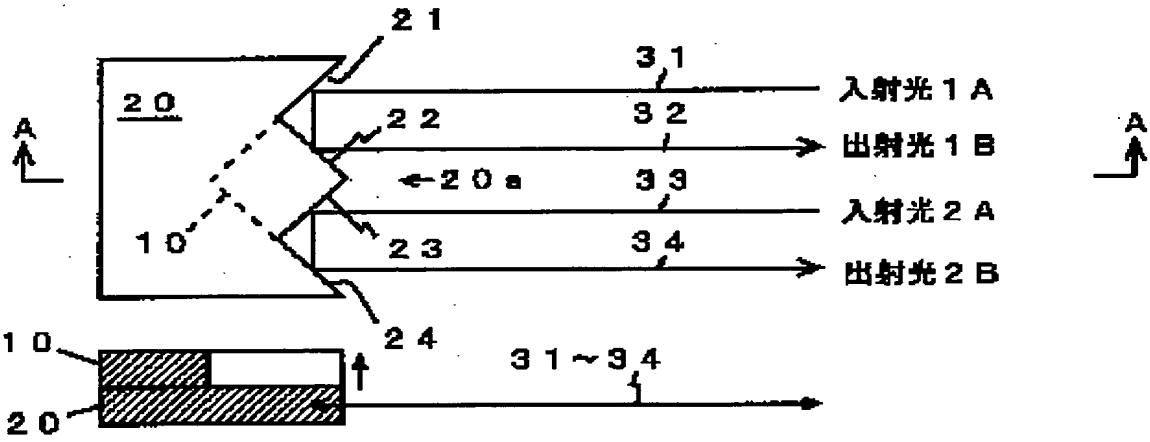
[Drawing 1]

(a)



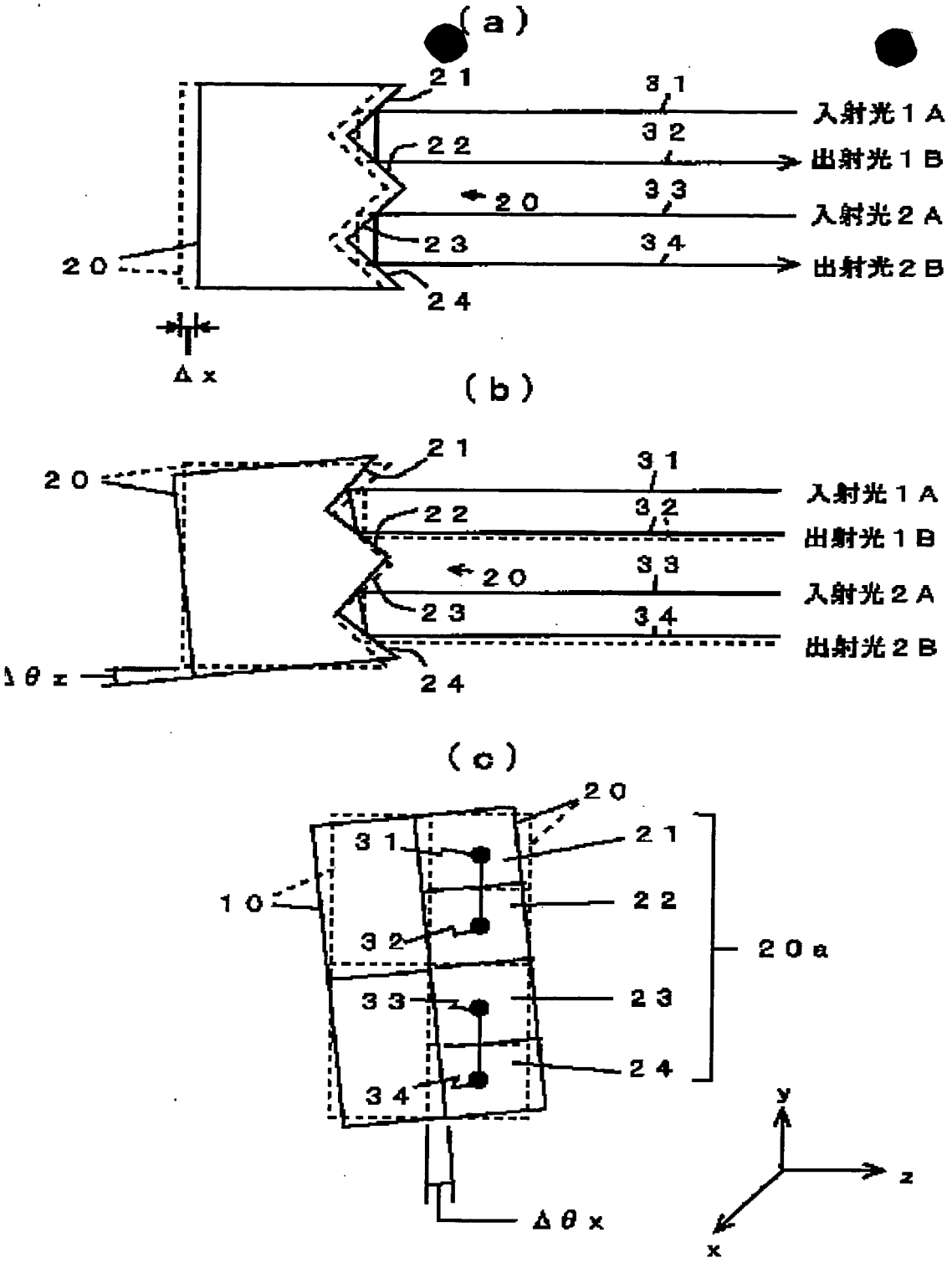
(A－A断面)

(b)

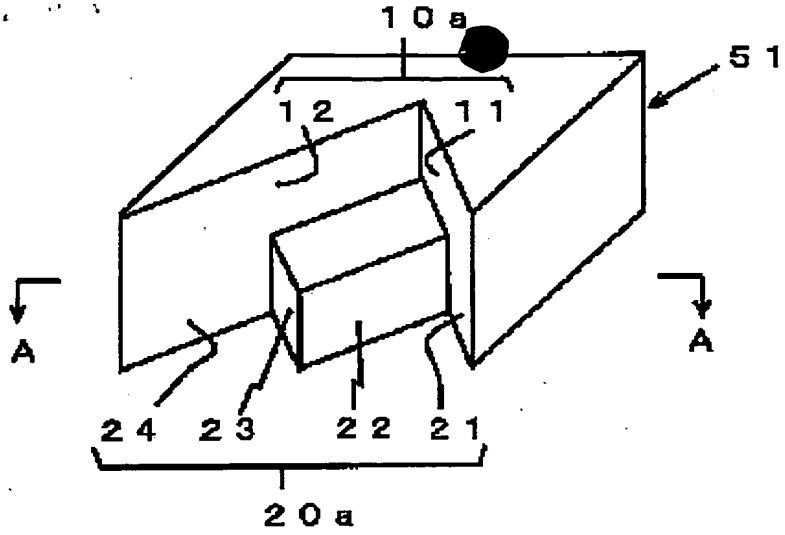


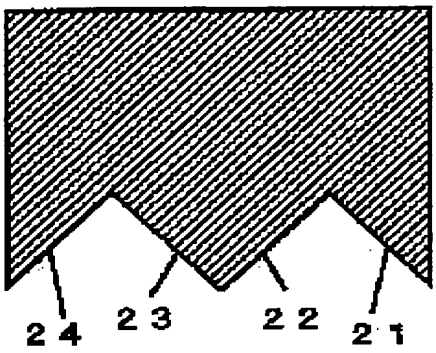
(A－A断面)

[Drawing 2]


(a)
21
31
入射光１A
32
22
出射光１B
20
33
入射光２A
23
34
出射光２B
20
24
Δx
(b)
21
31
入射光１A
22
32
出射光１B
20
33
入射光２A
23
34
出射光２B
Δθz
24
(c)
20
31
21
10
22
32
20a
33
23
24
34
y
z
Δθx
x

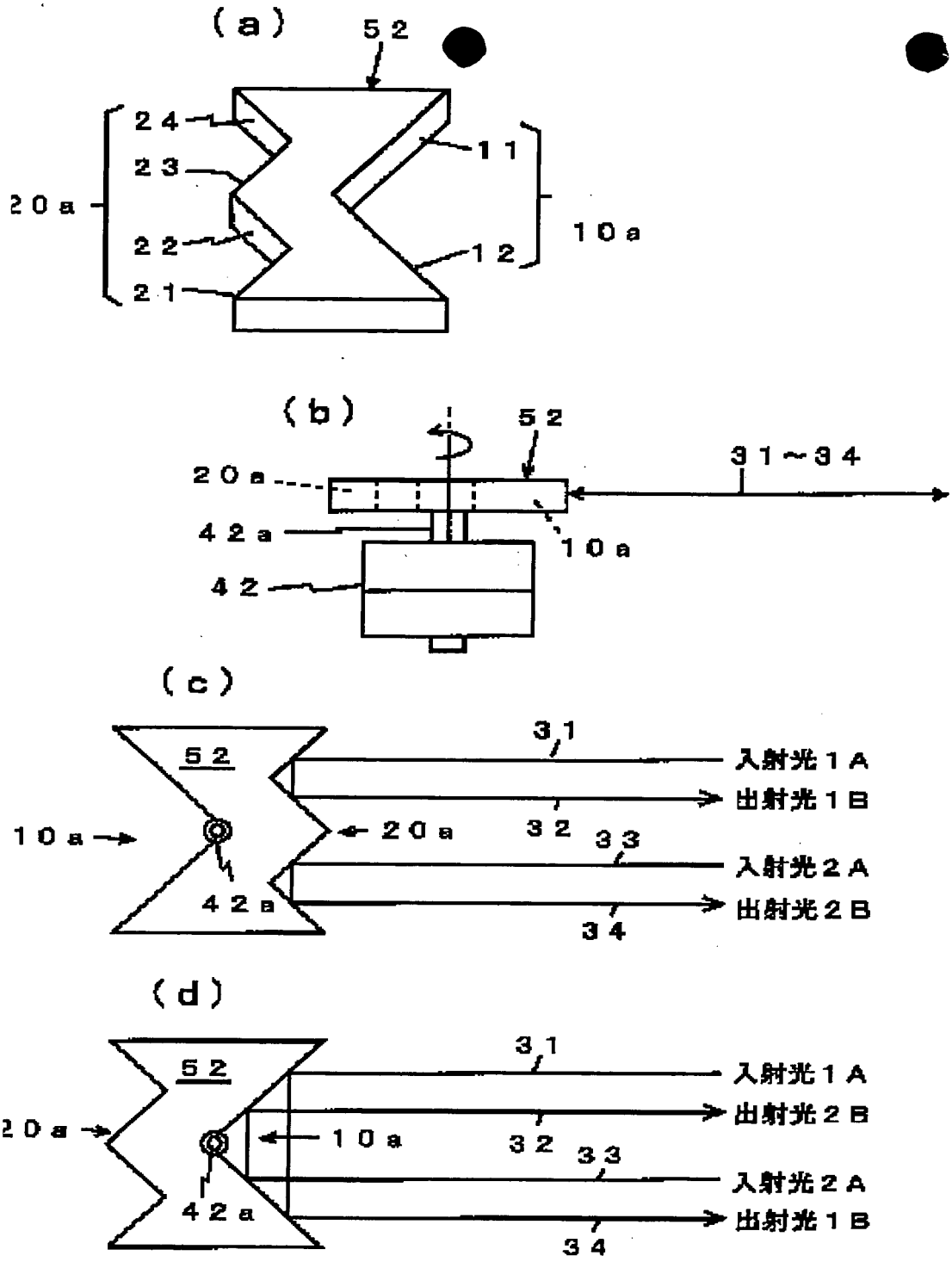
[Drawing 3]



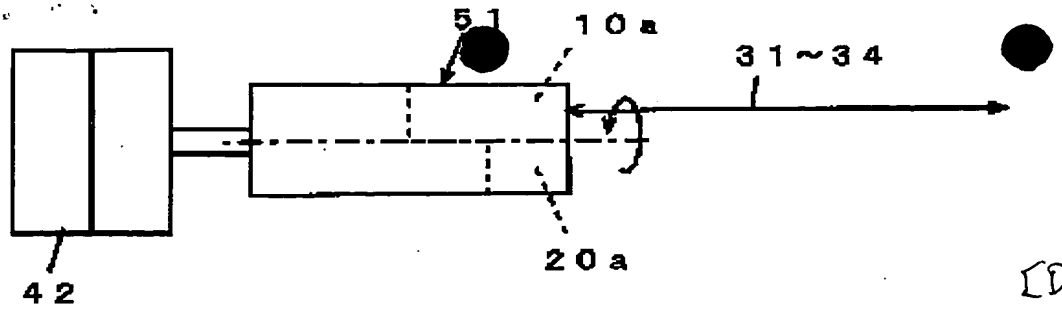


（A－A断面））

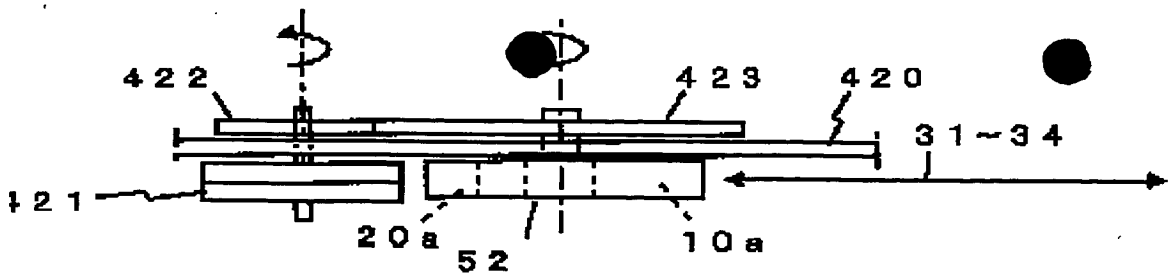
[Drawing 4]


(a)
52
24
23
22
21
20a
11
12
10a
(b)
52
31～34
20a
42a
42
10a
(c)
52
31
入射光1A
出射光1B
10a
20a
32
33
入射光2A
出射光2B
42a
34
(d)
52
31
入射光1A
出射光2B
20a
10a
32
33
入射光2A
出射光1B
42a
34

[Drawing 5]

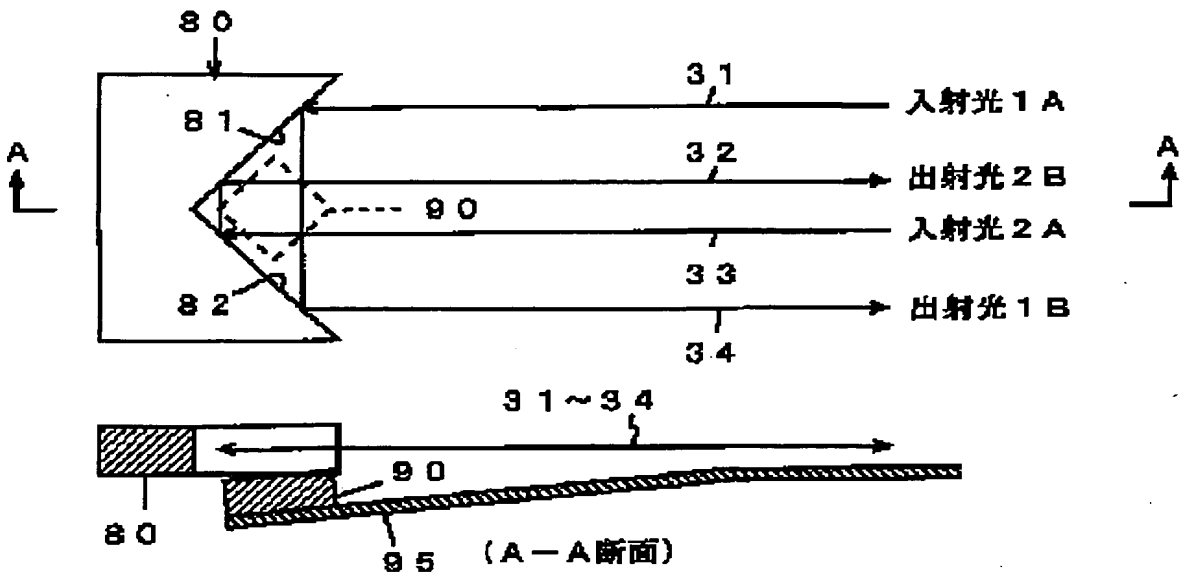


[Drawing 6]

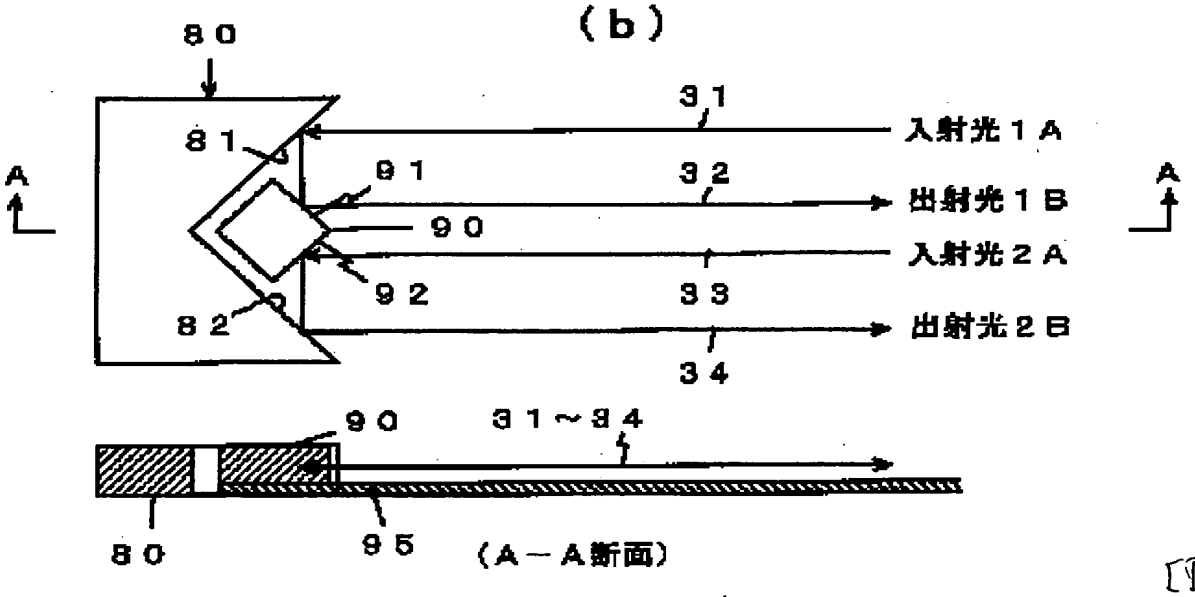


[Drawing 7]

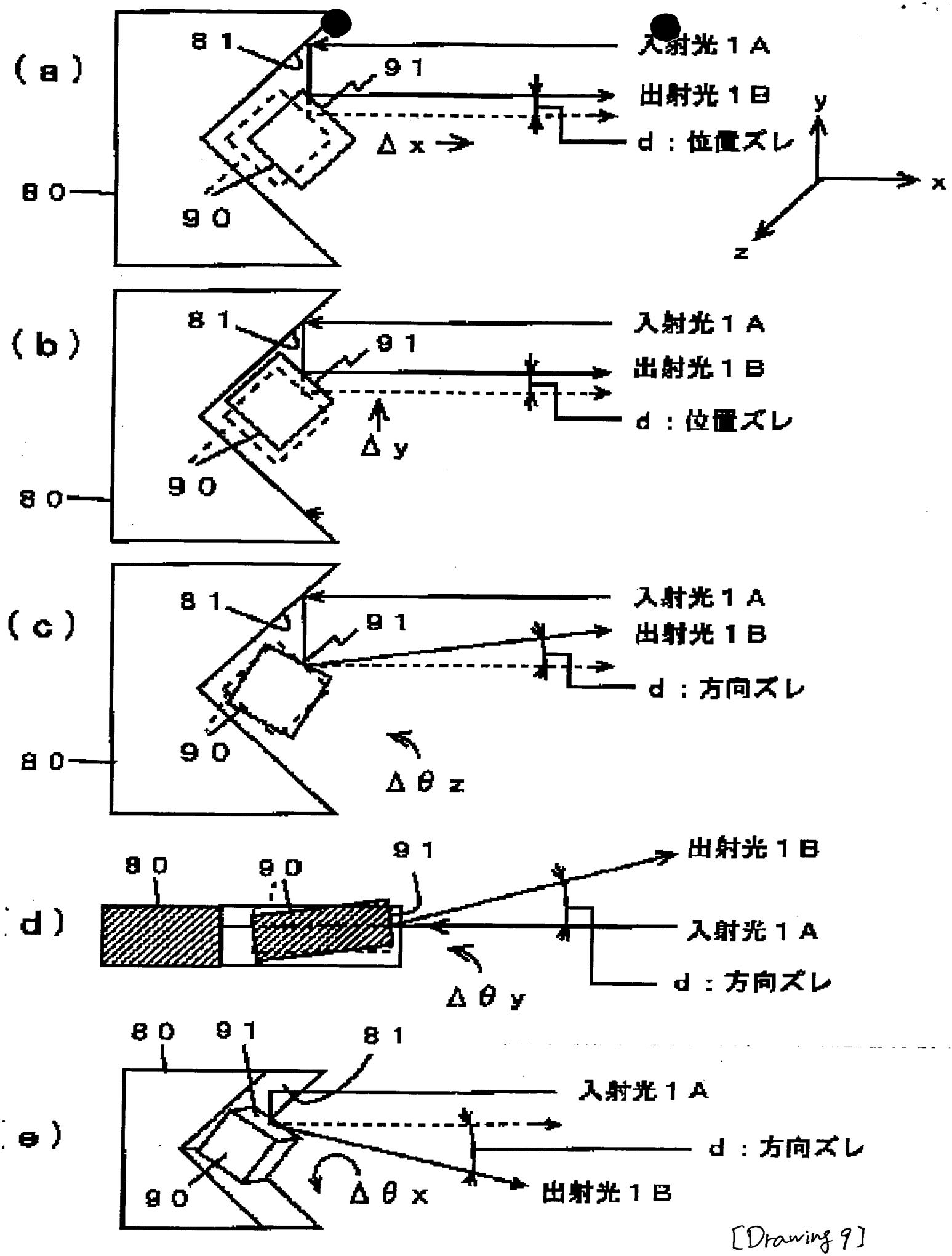
(a)


80
81
82
90
31
32
33
34
入射光１A
出射光２B
入射光２A
出射光１B
A
A
31～34
90
80
95
（A－A断面）

(b)


80
81
82
91
92
90
31
32
33
34
入射光１A
出射光１B
入射光２A
出射光２B
A
A
90
31～34
80
95
（A－A断面）

[Drawing 8]


(a)
81
91
入射光1A
出射光1B
d：位置ズレ
Δx
80
90
y
x
z
(b)
81
91
入射光1A
出射光1B
d：位置ズレ
Δy
90
80
(c)
81
91
入射光1A
出射光1B
d：方向ズレ
90
80
Δθz
d)
80
90
91
出射光1B
入射光1A
d：方向ズレ
Δθy
e)
80
91
81
入射光1A
d：方向ズレ
90
Δθx
出射光1B

[Drawing 9]

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（P2003－295072A）
(43)公開日　平成15年10月15日(2003.10.15)

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Ｇ０２Ｂ　26/08		Ｇ０２Ｂ　26/08	Ｅ　2Ｈ０４１

審査請求　未請求　請求項の数13　ＯＬ　（全　８　頁）

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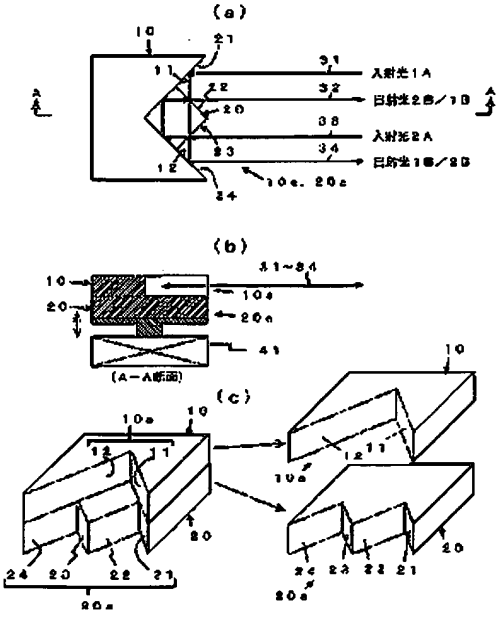
Ｆターム(参考)　2Ｈ041　AA15　AB13　AB15　AC01　AZ05
AZ08

(54)【発明の名称】　メカニカル光スイッチ

(57)【要約】
【課題】　比較的簡単で低コスト化に適した構成でもって、結合誤差が小さく伝送損失等の特性にすぐれたメカニカル光スイッチを得る。
【解決手段】　光の入出射光路３２、３４に回帰反射面を位置させるとともに、その回帰反射面の反射形状を変化させることにより光路切り替えを行うメカニカル光スイッチにおいて、あらかじめ形成されたＶ字状回帰反射面１０ａとＷ字状回帰反射面２０ａを上記入出射光路３１～３４に交互に位置させることにより光路切り替えを行わせる。



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【特許請求の範囲】

【請求項１】　光の入出射光路に回帰反射面を位置させるとともに、その回帰反射面の反射形状を変化させることにより光路切り替えを行うメカニカル光スイッチにおいて．あらかじめ形成されたＶ字状回帰反射面とＷ字状回帰反射面を上記入出射光路に交互に位置させることにより光路切り替えを行わせるようにしたことを特徴とするメカニカル光スイッチ。

【請求項２】　請求項１において、Ｖ字状回帰反射面を形成する第１の可動反射部材とＷ字状回帰反射面を形成する第２の可動反射部材を．前記光路上に交互に位置させることにより光路切り替えを行うことを特徴とするメカニカル光スイッチ。

【請求項３】　請求項１において、Ｖ字状回帰反射面とＷ字状回帰反射面を１つの集合型可動反射部材に形成し．この集合型可動反射部材を移動させることにより光路切り替えを行うことを特徴とするメカニカル光スイッチ。

【請求項４】　請求項３において、前記集合型可動反射部材のＶ字状回帰反射面とＷ字状回帰反射面は．共に同一方向を向き．かつ互いに積層方向に並んで形成されていることを特徴とするメカニカル光スイッチ。

【請求項５】　請求項４において、Ｗ字状回帰反射面を形成する４つの反射面のうち、その両側端に位置する２つの反射面がＶ字状回帰反射面を形成する反射面と同一面をなすことを特徴とするメカニカル光スイッチ。

【請求項６】　請求項３において、前記集合型可動反射部材のＶ字状回帰反射面とＷ字状回帰反射面は．互いに異方向を向き．かつ共に同一面上に位置するように形成されていることを特徴とするメカニカル光スイッチ。

【請求項７】　請求項６において、前記集合型可動反射部材は平板状であって、その一端側面にＶ字状回帰反射面が形成されるとともに、その正反対側面にＷ字状回帰反射面が形成されていることを特徴とするメカニカル光スイッチ。

【請求項８】　請求項１～６において．前記集合型可動反射部材を往復移動させることによりＶ字状回帰反射面とＷ字状回帰反射面を前記光路上に交互に位置させることを特徴とするメカニカル光スイッチ。

【請求項９】　請求項１～７において．前記集合型可動反射部材を回転移動させることによりＶ字状回帰反射面とＷ字状回帰反射面を前記光路上に交互に位置させることを特徴とするメカニカル光スイッチ。

【請求項１０】　請求項１～９において、前記集合型可動反射部材をステッピングモータで移動駆動することによりＶ字状回帰反射面とＷ字状回帰反射面を前記光路上に交互に位置させることを特徴とするメカニカル光スイッチ。

【請求項１１】　請求項１０において．前記集合型可動反射部材とステッピングモータを共に同一面上に配置し．両者を伝動機構を介して連結したことを特徴とするメカニカル光スイッチ。

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【請求項１２】　請求項１１において．前記伝動機構として平歯車を用いたことを特徴とするメカニカル光スイッチ。

【請求項１３】　請求項１～１２において、前記光路は同一平面上で平行に並んでそれぞれに光ファイバ伝送路に光結合されることを特徴とするメカニカル光スイッチ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は．光の伝送方向を切り替えるメカニカル光スイッチに関し、たとえば光ファイバ伝送路や光送受信端末装置の切り替えに使用される。

【０００２】

【従来の技術】メカニカル光スイッチは光の伝送方向を切り替えるために機械的な可動部分を有するが．原理がシンプルで比較的安価なことにより．光通信とくに光ファイバ伝送路を用いた光通信において．伝送ルートの変更や端末装置の切り替えなどに広く使われている。

【０００３】図８は従来のメカニカル光スイッチの一例を示す。同図に示す光スイッチはミラー（光反射鏡）を用いて光路を替える方式のものであって、固定反射部材８０と可動反射部材９０を用いて構成される。

【０００４】固定反射部材８０は互いに直角（９０度）の角度をなしながらＶ字状に開く第１．第２の反射面８１．８２を有する。この直角のＶ字状反射面８１．８２は入射光１Ａ．２Ａを正反対の戻り方向へ折り返し反射する回帰反射面を形成する。つまり．入射光１Ａ．２Ａの光路３１，３３と出射光１Ｂ，２Ｂの光路３２．３４が平行になるような回帰反射を行う。各光路３１～３４は光学的な自由伝播空間内の光路であって、通常は同一平面上に平行に並べられる。各光路３１～３４はそれぞれ所定位置に配置された光ファイバ伝送路にそれぞれ光学結合される。

【０００５】可動反射部材９０は互いに直角（９０度）の角度をなしながら逆Ｖ字状に開じる第１，２の反射面９１．９２を有する。この可動反射部材９０はカンチレバー９５の先端部に取り付けられて上下移動可能に保持されている。カンチレバー９５は適当な機械駆動手段により可動反射部材９０を上側と下側の２つの位置間を移動させる。

【０００６】可動反射部材９０が下側位置に移動した場合は．（ａ）に示すように．固定反射部材８０だけが入出射光路３１～３４上に位置させられて、第１と第２の反射面８１，８２によるＶ字状の回帰反射面が形成される。この場合．光路３１の入射光１Ａは、第１反射面８１と第２反射面８２で順次反射されて光路３４へ出射される。また、光路３３の入射光２Ａは．第２反射面８２

と第１反射面８１で順次反射されて光路３２へ出射される。

【０００７】一方、可動反射部材９０が上側位置に来た場合は、（ｂ）に示すように、上記入出射光路３１～３４上に固定反射部材と８０可動反射部材９０が位置させられて、両部材８０，９０によるＷ字状の回帰反射面が形成される。このＷ字状回帰反射面は、固定反射部材８０側の第１反射面８１と可動反射部材９０側の第１反射面９１によるＶ字状回帰反射部と、固定反射部材８０側の第２反射面８２と可動反射部材９０側の第２反射面９２によるＶ字状回帰反射部とによって形成される。

【０００８】この場合、光路３１の入射光１Ａは、固定反射部材８０側の第１反射面８１と可動反射部材９０側の第１反射面９１で順次反射されて光路３２へ出射される。また、光路３３の入射光２Ａは、固定反射部材８０側の第２反射面８２と可動反射部材９０側の第２反射面９２で順次反射されて光路３４へ出射される。このようにして、出射光１Ｂ，２Ｂの光路３２，３４を切り替え交換する光スイッチ動作が行われる。

【０００９】上述したメカニカル光スイッチは、入射光路３１，３３と出射光路３２，３４が同一側にあるので、小形化に有利であるとともに配置上の自由度が高いといった利点がある。

【００１０】

【発明が解決しようとする課題】上述した従来のメカニカル光スイッチでは、可動反射部材９０を移動させて光路を切り替えるが、その切り替えは、出射光路３２，３４の位置が変動しないように行わなければならない。出射光路３２，３４はあらかじめ位置決めされた光ファイバ伝送路に光結合されるが、その出射光路３２，３４の位置が変動すると、光ファイバ伝送路との結合に誤差（エラー）が生じる。この結合誤差が大きくなると伝送損失が増大し、最悪の場合は光伝送が遮断されてしまう。

【００１１】上記結合誤差を小さくするためには、固定反射部材８０、可動反射部材９０、光ファイバ伝送路を互いに正確に位置決めする必要がある。とくに、固定反射部材８０と可動反射部材９０については、入射光１Ａ、２Ａをその入射方向と正反対の戻り方向へ正確に折り返し反射させるＷ字状の回帰反射面を形成する必要上、両者間の相対精度を極力高精度に保つ必要がある。しかし、機械的に移動可能に構成された可動反射部材９０を固定反射部材８０に対して高精度かつ高安定に位置決めさせようとすると、位置合せ調整の必要個所が多く、組立工程が複雑でコストが高くなるという問題が生じる。さらに、可動反射部材９０を移動させる機械駆動系にも十分な高精度と安定性が要求されるが、これも工程の複雑化と高コスト化をもたらす。

【００１２】図９は、上記可動反射部材９０の相対位置ズレにより生じる出射光１Ｂの位置ズレｄ状態を示す。

同図において、（ａ）はｘ方向（紙面の左右方向）の位置ズレΔｘが生じた場合、（ｂ）はｙ方向（紙面の上下方向）の位置ズレΔｙが生じた場合、（ｃ）はｚ方向軸（紙面の垂直方向）を中心とする回転ズレΔθｚが生じた場合、（ｄ）はｙ方向軸を中心とする回転ズレΔθｚが生じた場合、（ｅ）はｘ方向軸を中心とする回転ズレΔθｘが生じた場合をそれぞれ示す。同図に示すように、可動反射部材９０と固定反射部材８０間には様々なモードの相対位置ズレ（Δｘ，Δｙ，Δθｚ，Δθｙ）が生じ、そのいずれもが回帰反射された出射光１Ｂの位置または方向に大きなズレｄをもたらす。そして、このズレｄは伝送損失増大といった特性低下をもたらす。

【００１３】この発明は以上のような問題に鑑みてなされたもので、その目的は、比較的簡単で低コスト化に適した構成でもって、結合誤差が小さく伝送損失等の特性にすぐれたメカニカル光スイッチを提供することにある。

【００１４】

【課題を解決するための手段】本発明による手段は、光の入出射光路に回帰反射面を位置させるとともに、その回帰反射面の反射形状を変化させることにより光路切り替えを行うメカニカル光スイッチにおいて、あらかじめ形成されたＶ字状回帰反射面とＷ字状回帰反射面を上記入出射光路に交互に位置させることにより光路切り替えを行わせるようにしたことを特徴とする。

【００１５】上記手段よれば、比較的簡単で低コスト化に適した構成でもって、結合誤差が小さく伝送損失等の特性にすぐれたメカニカル光スイッチを得ることができる。さらに、本発明では、上記手段の好ましい態様として、次のような手段を提供する。

【００１６】すなわち、上記光路切り替えは、Ｖ字状回帰反射面を形成する第１の可動反射部材とＷ字状回帰反射面を形成する第２の可動反射部材を上記光路上に交互に位置させることにより行わせることができる。また、Ｖ字状回帰反射面とＷ字状回帰反射面を１つの集合型可動反射部材に形成し、この集合型可動反射部材を移動させることによっても行わせることができる。

【００１７】上記集合型可動反射部材のＶ字状回帰反射面とＷ字状回帰反射面は、共に同一方向を向き、かつ互いに横断方向に並んで形成することができる。この場合、Ｗ字状回帰反射面を形成する４つの反射面のうち、その両側端に位置する２つの反射面は、Ｖ字状回帰反射面を形成する反射面と同一面に形成することができる。

【００１８】上記集合型可動反射部材のＶ字状回帰反射面とＷ字状回帰反射面は、互いに異方向を向き、かつ共に同一面上に位置するように形成してもよい。たとえば、平板状の集合型可動反射部材の一端側面にＶ字状回帰反射面を形成するとともに、その正反対側面にＷ字状回帰反射面を形成するとよい。

【００１９】Ｖ字状回帰反射面とＷ字状回帰反射面を上

記光路上に交互に位置させるためには．上記集合型可動反射部材を往復移動または回転移動させればよい。その移動駆動手段としてはオープンループ制御で駆動できるステッピングモータが好適である。ステッピングモータはディテントトルクを有するが、このディテントトルクは可動反射部材の位置決め状態を安定に保持する効果をもたらす。

【００２０】集合型可動反射部材とステッピングモータを共に同一面上に配置し．両者を伝動機構を介して連結することにより．光スイッチの薄型化をはかることができる。この場合の伝動機構としては平歯車が適している。

【００２１】上述した本発明の手段は．上記光路が同一平面上で平行に並んでそれぞれが光ファイバ伝送路に光結合されるタイプのメカニカル光スイッチに適している。

【００２２】

【発明の実施の形態】図１は、本発明によるメカニカル光スイッチの第１実施例を示す。同図において．（ａ）は光信号の入出射光路３１～３４を上側から見た平面図．（ｂ）はＡ－Ａ断面図．（ｃ）は要部斜視図をそれぞれ示す。

【００２３】同図に示すメカニカル光スイッチは．Ｖ字状の回帰反射面１０ａを有する第１の可動反射部材１０と．Ｗ字状の回帰反射面２０ａを有する第２の可動反射部材２０と、両反射部材１０，２０を入出射光路３１～３４上に交互に位置させるアクチェータ（往復駆動手段）４１を用いて構成されている。入出射光路３１～３４は光学的な自由伝播空間内の光路であって、通常は同一平面上に平行に並ぶように配置される。各光路３１～３４はそれぞれ所定位置に配置された光ファイバ伝送路（図示省略）に光学結合される。

【００２４】第１の可動反射部材１０は、互いに直角（９０度）の角度をなしながらＶ字状に開く第１．第２の反射面１１．１２により．入射光１Ａ，２Ａを正反対の戻り方向へ折り返し反射するＶ字状回帰反射面１０ａを形成する。第２の可動反射部材２０は、直角（９０度）の角度でＷ字状に配置された第１～４の反射面２１～２４により．２つのＶ字状回帰反射部からなるＷ字状回帰反射面２０ａを形成する。この場合、第２の可動反射部材２０の反射面２１～２４のうち．Ｗ字状回帰反射面２０ａの両側端に位置する２つの反射面２１．２４については、第１の可動反射部材１０のＶ字状回帰反射面１０ａをなす２つの反射面１１，１２と同一面をなす。

【００２５】上述した第１．第２の可動反射部材１０，２０は共に、リニア駆動型のアクチェータ４１により上下２つの位置間を移動させられるようになっている。アクチェータ４１はたとえば電磁ソレノイドなどを用いて構成され、上記部材１０．２０を上下に往復移動させる。

【００２６】図２は、上記メカニカル光スイッチのスイッチ動作を示す。上記メカニカル光スイッチは．（ａ）と（ｂ）に示すように、第１，第２の可動反射部材１０．２０を光路３１～３４上に交互に位置させることにより．出射光１Ｂ，２Ｂの光路３２．３４を交互に切り替える光スイッチとして動作する。（ａ）は、第１の可動反射部材１０のＶ字状回帰反射面１０ａが光路３１～３４上に位置させられたときの状態を示す。この状態では．光路３１の入射光１Ａが反射面１１と１２で回帰反射されて光路３４上に出射（１Ｂ）される。また．光路３３の入射光２Ａが反射面１２と１１で回帰反射されて光路３２上に出射（２Ｂ）される。各出射光路３２，３４上の出射光１Ｂ，２Ｂはそれぞれ．その光路３２，３４の先に位置する光ファイバ伝送路に導かれる。光ファイバ伝送路は上記光路３１～３４と光結合する位置にあらかじめ配置されている。（ｂ）は．第２の可動反射部材２０のＷ字状回帰反射面２０ａが光路３１～３４上に位置させられたときの状態を示す。この状態では．光路３１の入射光１Ａが反射面２１と２２で回帰反射されて光路３２上に出射（１Ｂ）される。また、光路３３の入射光２Ａが反射面２３と２４で回帰反射されて光路３４上に出射（２Ｂ）される。この場合も．各出射光路３２．３４上の出射光１Ｂ．２Ｂはそれぞれ、その光路３２．３４の先に位置する光ファイバ伝送路に導かれる。上記（ａ）と（ｂ）の２つの状態をアクチェータ４１で機械的に遷移させることにより、出射光１Ｂ，２Ｂの光路３２，３４を交互に切り替える光スイッチ動作が行われる。

【００２７】ここで、（ａ）の状態のときに光路３１～３４上に位置するＶ字状回帰反射面は．第１の可動反射部材１０にあらかじめ形成されている。同様に．（ｂ）の状態のときに光路３１～３４上に位置するＷ字状回帰反射面は、第２の可動反射部材２０にあらかじめ形成されている。したがって、仮に第１の可動反射部材１０に対して光路の位置決めを行い、それに対し、第２の可動反射部材２０は回帰反射面２０ａの形状が正しく維持されるため、３つの自由度について位置ズレによる影響を軽減することができる。つまり、可動反射部材１０，２０に位置ズレが生じたとしても、各可動反射部材１０，２０がそれぞれに形成する回帰反射面１０ａ，２０ａの形状には変化が生じないので、出射光路３２，３４に大きな位置ズレが生じるという事態は回避できる。これにより．結合誤差が小さく伝送損失等の特性にすぐれたメカニカル光スイッチを提供できる。次にその詳細について述べる。

【００２８】図３は、上記可動反射部材１０，２０に位置ズレが生じたときの出射光路３２．３４の挙動を例示する。同図において、（ａ）はｘ方向の位置ズレΔｘが生じた場合を示す。この場合、出射光路３２，３４の位置ズレはまったく生じない。（ｂ）はｚ方向軸を中心と

する回転ズレΔθｚが生じた場合を示す。この場合、回帰反射面の形状（９０度）は変化しないので、入出射光路は平行が保たれる。一方、前述した従来の可動反射面の場合には、反射面間の角度が９０度からずれるために、平行を保つことができなくなる。このような理由により、本発明では回転ズレΔθｚが生じても従来に比べ、光路のズレを最小に抑えることができる。（ｃ）はｘ方向軸を中心とする回転ズレΔθｘが生じた場合を示す。この場合も、回帰反射面の形状は変化しないので、ｘ成分は平行光となる。ただし、Δθｘの傾きの影響は反射面から見るとｚ成分の角度を持つが、２回の反射でキャンセルし、出射光は同じところに戻ってくる。

【００２９】出射光路３２、３４は、あらかじめ位置決めされた光ファイバ伝送路に光結合させられるが、回帰反射さえ正しく行われていれば、光路位置は若干平行移動することがあっても、光路方向が変化することはない。光路３２、３４は、その方向が変化しなければ、先に行くにしたがって位置ズレが拡大するということがないので、大きな伝送損失を伴うような結合誤差は生じない。また、平行方向への位置ズレだけならば位置合せ修正は簡単である。

【００３０】図４は本発明の第２実施例の要部を示す。上述した第１実施例では、２つの可動反射部材１０，２０を使用したが、この第２実施例では単一部品に一体化された１つの集合型可動反射部材５１を使用してメカニカル光スイッチを構成する。

【００３１】集合型可動反射部材５１には、Ｖ字状回帰反射面１０ａとＷ字状回帰反射面２０ａが共に同一方向を向き、かつ互いに積層方向に並んで形成されている。Ｖ字状反射面１０ａは部材５１の上側半分の厚み部分で形成され、この部分には、直角（９０度）の角度で斜めに向き合う第１、第２の反射面１１、１２が形成されている。Ｗ字状反射面２０ａは部材５１の下側半分の厚み部分で形成され、この部分には、２つのＶ字状回帰反射部をなす第１～第４の反射面２１～２４が形成されている。この集合型可動反射部材５１を用いれば、前記第１実施例に使用されている２つの可動反射部材１０、２０を１つの部品に集合させることができ、これにより、組立および位置合わせ工程をさらに効率化および簡略化させることができる。

【００３２】また、Ｗ字状回帰反射面２０ａを形成する４つの反射面２１～２４のうち、その両側端に位置する２つの反射面２１，２４については、Ｖ字状回帰反射面１０ａをなす２つの反射面１１，１２と同一面に形成することができる。したがって、その反射面１１、１２，２１、２４については１つの反射面として加工することができる。このことは反射部材５１の製造を簡単化する上で好都合である。

【００３３】図５は本発明の第３実施例を示す。この実施例のメカニカル光スイッチは、（ａ）に示すように、Ｖ字状回帰反射面１０ａとＷ字状回帰反射面２０ａが同一面上に位置するように配設された平板状の集合型可動反射部材５２を使用する。この集合型可動反射部材５２は、その一端側面にＶ字状回帰反射面１０ａが形成され、そこから１８０度回転した他端側面にＷ字状回帰反射面２０ａが形成されている。つまり、両反射面１０ａ、２０ａは同一平面上にて互いに正反対方向を向くように形成されている。この集合型可動反射部材５２は形状が平面的で単調なので作製が容易であるという利点がある。

【００３４】上記集合型可動反射部材５２は、（ｂ）に示すように、回転アクチェータ４２の回転軸４２ａに連結され、入出射光路３１～３４と同じ平面上に沿って１８０度回転移動させられるようになっている。これにより、（ｃ）または（ｄ）に示すように、Ｖ字状回帰反射面１０ａとＷ字状回帰反射面２０ａを入出射光路３１～３４上に交互に位置させることができる。

【００３５】上記回転アクチェータ４２にはステッピングモータを使用している。このステッピンモータは可動反射部材５２を１８０度の整数分の１のステップ角度で回転駆動するが、回転停止時にはその停止位置（角度）を保持するディテントトルクが生じる。このディテントトルクは上記可動反射部材５２を定位置に安定に静止させる位置決め効果をもたらす。

【００３６】なお、集合型可動反射部材のＶ字状回帰反射面とＷ字状回帰反射面は、必ずしも正反対側面に形成する必要はなく、互いに異方向を向き、かつ共に同一面上に位置すればよい。

【００３７】図６は本発明の第４実施例を示す。この実施例では、図１に示した集合型可動反射部材５１を回転移動させることにより、Ｖ字状回帰反射面１０ａとＷ字状回帰反射面２０ａを入出射光路３１～３４上に交互に位置させる。この場合、可動反射部材５１は、光路３１～３４の光軸方向を中心に回転駆動される。回転駆動はステッピングモータを用いた回転アクチェータ４２で行う。ステッピングモータは、上述したように、ディテントトルクを有するので、可動反射部材５１の停止位置を安定に保持することができる。

【００３８】図７は本発明の第５実施例を示す。同図に示すように、この実施例では、図５に示した板状の集合型可動反射部材５２と、この可動反射部材５２を回転移動させるアクチェータとしてのステッピングモータ４２１を共に同一面上に配置している。ステッピングモータ４２１と可動反射部材５２は、回転伝動機構をなす平歯車４２２，４２３を介して連結されている。４２０は各部材（４２１～４２３，５２）の取り付けベースを示す。この実施例では、可動反射部材５２とモータ４２１が同一面上に配置されていることにより、全体を薄型に構成できるという利点がある。

【００３９】以上、本発明をその代表的な実施例に基づ

いて説明したが．本発明は上述した以外にも種々の態様が可能である。たとえば．V字状とW字状の回帰反射面を一体に形成する集合型反射部材は上述した以外にも種々の形状が可能である。

【００４０】

【発明の効果】本発明によれば、比較的簡単で低コスト化に適した構成でもって．結合誤差が小さく伝送損失等の特性にすぐれたメカニカル光スイッチを得ることができる。

【図面の簡単な説明】

【図１】本発明によるメカニカル光スイッチの第１実施例を示す平面図．断面図および要部斜視図である。

【図２】図１に示したメカニカル光スイッチのスイッチ動作を示す図である。

【図３】本発明のメカニカル光スイッチにて可動反射部材の位置ズレが生じたときの出射光路の挙動を例示する図である。

【図４】本発明の第２実施例の要部を示す斜視図および断面図である。

【図５】本発明の第３実施例の構成と動作を示す斜視図．側面図、および平面図である。

【図６】本発明の第４実施例を示す側面図である。

【図７】本発明の第５実施例を示す側面図である。

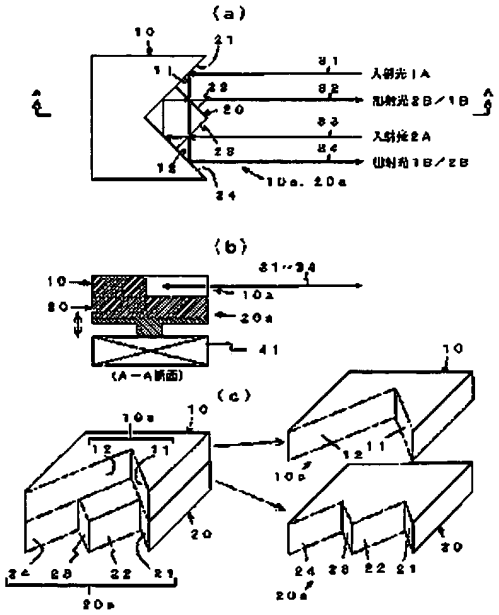
【図８】従来のメカニカル光スイッチを示す平面図、断面図．および斜視図である。

【図９】従来のメカニカル光スイッチにて可動反射部材の相対位置ズレにより生じる出射光の位置ズレ状態を示す＊す図である。

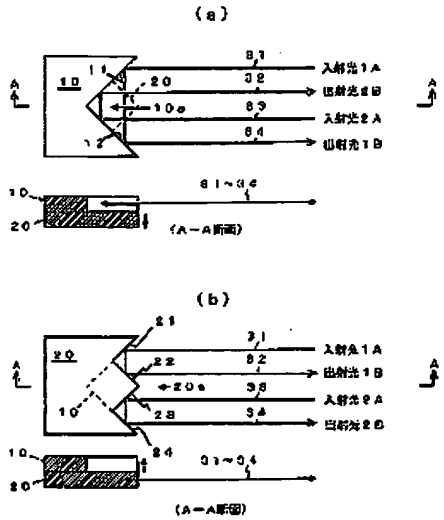
【符号の説明】

１Ａ、２Ａ　入射光
１Ｂ、２Ｂ　出射光
１０　第１の可動反射部材
１０ａ　Ｖ字状回帰反射面
１１、１２　Ｖ字状回帰反射面をなす第１，第２の反射面
２０　第２の可動反射部材
２０ａ　Ｗ字状回帰反射面
２１～２４　Ｗ字状回帰反射面をなす第１～第４の反射面
３１、３３　入射光路
３２、３４　出射光路
４１　アクチェータ（往復駆動）
４２　アクチェータ（回転駆動）
４２ａ　回転軸
４２０　取り付けベース
４２１　ステッピングモータ
４２２，４２３　平歯車
５１、５２　集合型可動反射部材
８０　固定反射部材（従来）
８１、８２　反射面
９０　可動反射部材（従来）
９１～９２　反射面
９５　カンチレバー

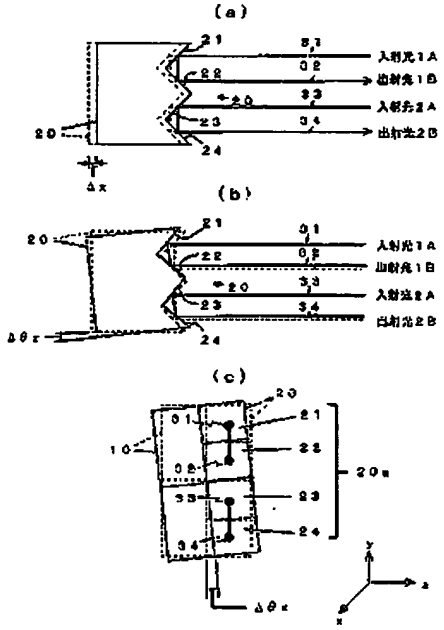
【図１】



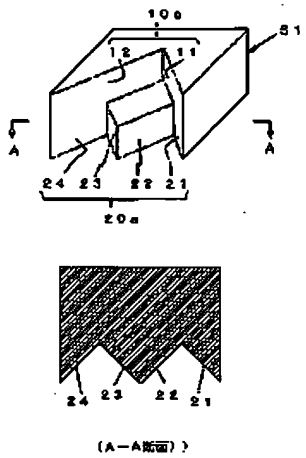
【図２】



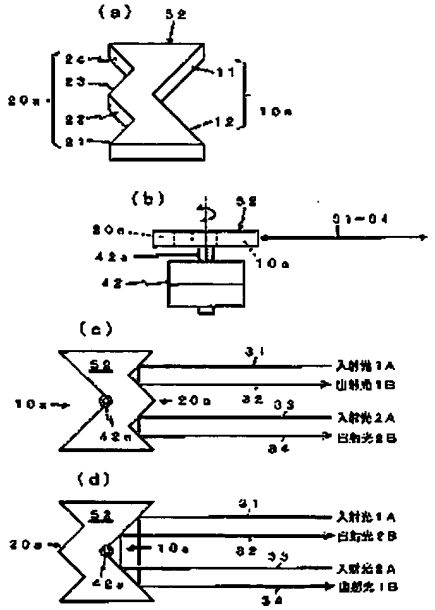
【図3】


(a)
入射光1A
出射光1B
入射光2A
出射光2B
(b)
入射光1A
出射光1B
入射光2A
出射光2B
(c)

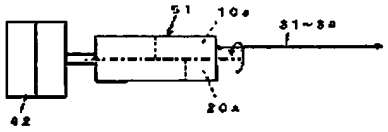
【図4】


(A-A断面)

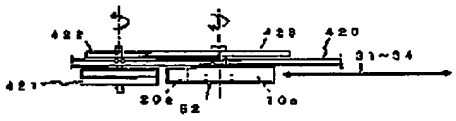
【図5】


(a)
(b)
(c)
入射光1A
出射光1B
入射光2A
出射光2B
(d)
入射光1A
出射光2B
入射光2A
出射光1B

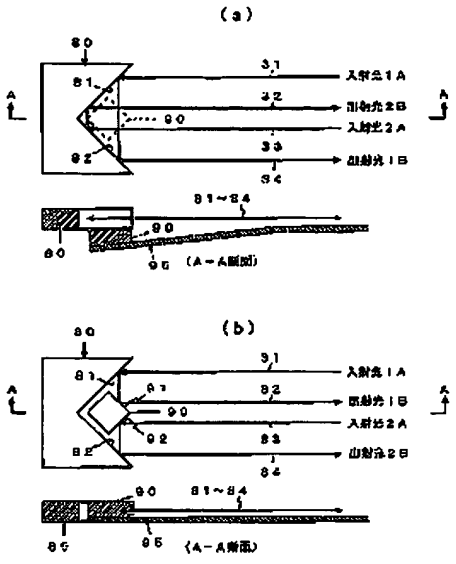
【図6】



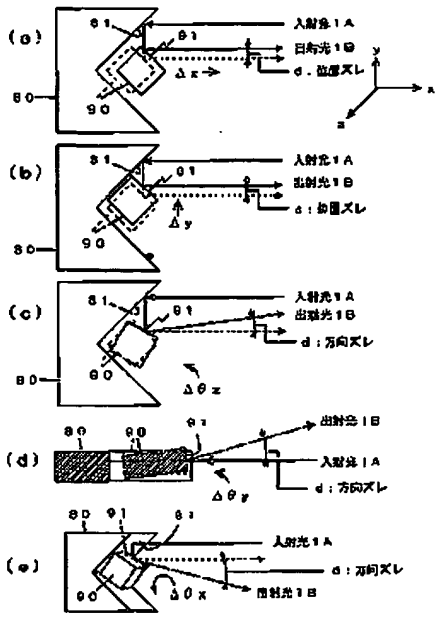
【図7】



【図8】


(a)
80
81
82
90
91
92
93
94
入射光1A
回折光2B
入射光2A
出射光1B
81～84
95
(A－A断面)
(b)
80
81
82
90
91
92
93
94
入射光1A
回折光1B
入射光2A
出射光2B
81～84
95
(A－A断面)

【図9】


(a)
(b)
(c)
(d)
(e)
入射光1A
回折光1B
出射光1B
d：位置ズレ
d：姿勢ズレ
d：方向ズレ
Δx
Δy
Δθz
Δθy
Δθx